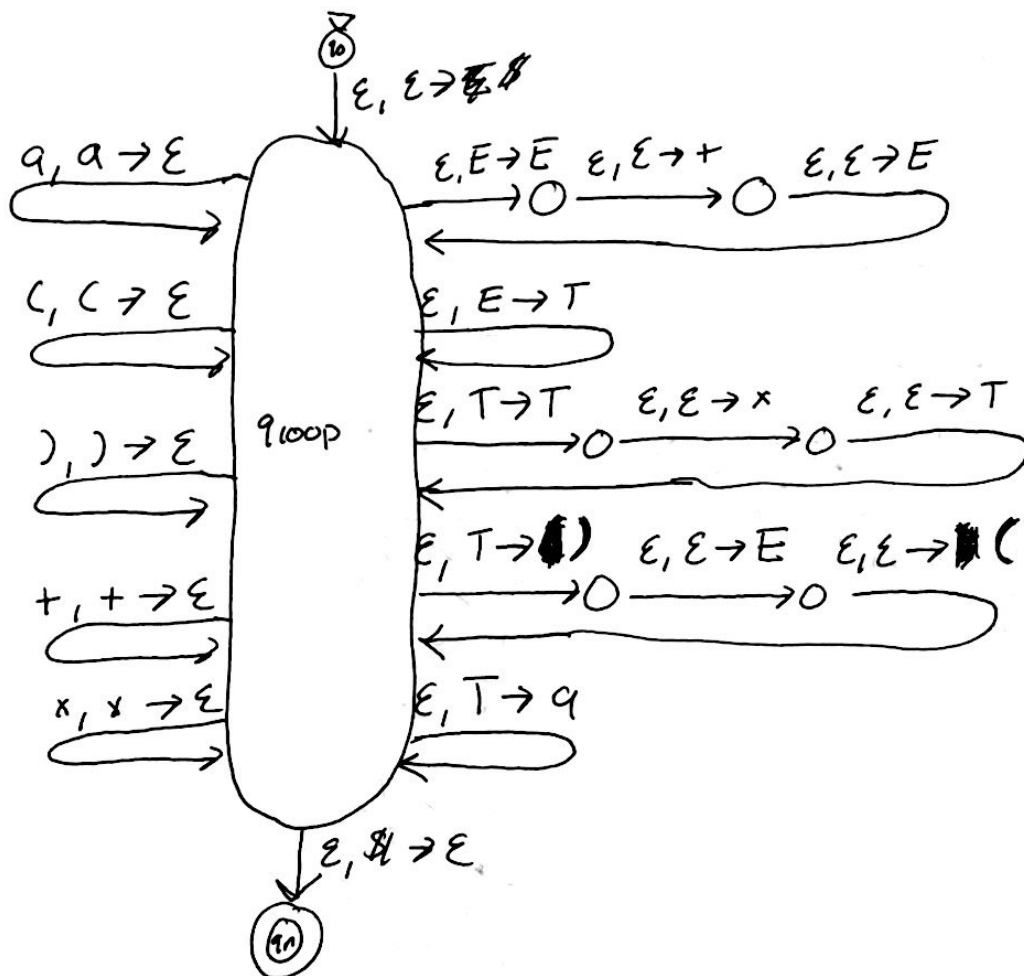


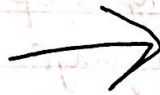
Annabel Consilvio #2

#2  $E \rightarrow E + E \mid T$   
 $T \rightarrow T * T \mid (E) \mid a$



#3

$$\begin{aligned}
 E_0 &\rightarrow T \times T \mid (E) \mid E + E \mid a \\
 E &\rightarrow T \times T \mid (E) \mid E + E \mid a \\
 T &\rightarrow T \times T \mid (E) \mid a \\
 E_1 &\rightarrow EE_2 \\
 E_2 &\rightarrow PE \\
 P &\rightarrow + \\
 K &\rightarrow x \\
 R &\rightarrow ) \\
 L &\rightarrow (
 \end{aligned}$$

$$\begin{aligned}
 E_0 &\rightarrow T \times T \mid (E) \mid EE_1 \mid a \\
 E &\rightarrow T \times T \mid (E) \mid EE_1 \mid a \\
 T &\rightarrow T \times T \mid (E) \mid a \\
 E_1 &\rightarrow EE_2 \\
 E_2 &\rightarrow PE \\
 P &\rightarrow + \\
 K &\rightarrow x \\
 R &\rightarrow ) \\
 L &\rightarrow (
 \end{aligned}$$


$$\begin{aligned}
 E_0 &\rightarrow TT_1 \mid (E) \mid EE_1 \mid a \\
 E &\rightarrow TT_1 \mid (E) \mid EE_1 \mid a \\
 T &\rightarrow TT_1 \mid (E) \mid a \\
 T_1 &\rightarrow TT_2 \\
 T_2 &\rightarrow KT \\
 E_1 &\rightarrow EE_2 \\
 E_2 &\rightarrow PE \\
 K &\rightarrow x \\
 P &\rightarrow + \\
 R &\rightarrow ) \\
 L &\rightarrow ( \\
 E_3 &\rightarrow ER
 \end{aligned}$$


$$\begin{aligned}
 E_0 &\rightarrow TT_1 \mid LE_3 \mid EE_1 \mid a \\
 E &\rightarrow TT_1 \mid LE_3 \mid EE_1 \mid a \\
 T &\rightarrow TT_1 \mid LE_3 \mid \cancel{a} \\
 T_1 &\rightarrow TT_2 \\
 T_2 &\rightarrow KT \\
 K &\rightarrow x \\
 E_1 &\rightarrow EE_2 \\
 E_2 &\rightarrow PE \\
 P &\rightarrow + \\
 R &\rightarrow ) \\
 L &\rightarrow ( \\
 E_3 &\rightarrow ER
 \end{aligned}$$

4. This is not a regular language because  $(^n a)^n \rightarrow (((((a))))))$  is in the language, and if we take any loop of this it will no longer be in the language.

$((a)) \rightarrow (((a))) \times \quad ((a)) \rightarrow (((a)))) \times$

$((a)) \rightarrow ((a)(a)) \times \quad (((a))) \rightarrow ((a)) \times$

5.  $a^n b^n c^n$  is not context free

U.e.  $\{a^i b^j c^j\} \checkmark$  CFL  $L_2: \{a^i b^j c^j\} = \text{CFL} \checkmark$

$S_0 \rightarrow S$

$S \rightarrow EF$

$E \rightarrow aEb | E | \epsilon$

$F \rightarrow cF | \epsilon$

$S_0 \rightarrow S$

$S \rightarrow EF$

$E \rightarrow aE | \epsilon$

$F \rightarrow cF | \epsilon$

Because  $\{a^i b^j c^j\}$  we know is not a context free language but  $L_1$  and  $L_2$  are both CFL and that  $\{a^i b^j c^j\}$  is in both  $L_1$  and  $L_2$ , we can see that CFL are not closed under intersection. ( $\{a^i b^j c^j\}$  is the case where  $j=i$ )

b. Take the string  $aaabbbbbbcccc$

Any option  $> 1$  chosen in this string to pump will be wrong.

$aaabbbbbbcccc \rightarrow aaaaaabbbbbbcccc \quad n \neq n, n$

$aaabbbbbbcccc \rightarrow aaababbbbbbcccc \quad n \neq n$

because all  $a, b, c$  have to exist in equal numbers, and since you can't pump the whole string, adding any additional letters will change this